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Fibre ropes for offshore stationkeeping —

Part 5: **Aramid**

Cordages en fibres pour le maintien en position des structures marines —

Partie 5: Aramide

Reference number
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Foreword

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This document was prepared by Technical Committee ISO/TC 38, *Textiles*.

This first edition of ISO 18692-5 cancels and replaces ISO/TS 17920:2015, which has been technically revised.

The main changes are as follows:

— the document previously, published as a Technical Specification, has been reorganized as the new ISO 18692-5, taking into account the content of ISO 18692-1.

A list of all parts in the ISO 18692 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Fibre ropes for offshore stationkeeping —

Part 5: **Aramid**

1 Scope

This document specifies the main characteristics and test methods of new aramid fibre ropes used for offshore stationkeeping.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1968, *Fibre ropes and cordage — Vocabulary*

ISO 18692-1:2018, *Fibre ropes for offshore stationkeeping — Part 1: General specification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1968, ISO 18692-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
aramid
long-chain synthetic polyamide in which at least 85 % of the amide linkages are attached directly to two aromatic rings

Note 1 to entry: Adapted from ISO 2076:2021, 5.9.

3.2
axial compression fatigue
failure mode for fibre rope such as *aramid* (3.1) under low tension or compression

4 Materials

The fibre used in the core of the rope shall be aramid fibre, with an average tenacity of not less than 1,8 N/tex, and shall be qualified and tested in accordance with Annex A.

Rope cover material and other materials employed in rope assembly shall be in accordance with ISO 18692-1.

5 Requirements — Rope properties

5.1 Minimum breaking strength

The minimum breaking strength (MBS) of the rope (spliced),when tested according to ISO 18692-1, shall conform to Table 1.

Table 1 — Minimum breaking strength (MBS)

Reference number(RN) [a]	Minimum breaking strength kN
80	2 500
90	3 100
100	3 900
106	4 400
112	5 000
118	5 600
125	6 300
132	7 000
140	7 800
150	8 700
160	10 000
170	11 200
180	12 500
190	14 000
200	15 500
212	17 500
224	19 500

[a] The reference number corresponds to the approximate outer diameter of the rope, in millimetres (mm). Actual diameters may vary for a given reference number.

5.2 Minimum core tenacity

The minimum tenacity of the aramid rope core shall be 0,90 N/tex, measured according to ISO 18692-1. All samples tested shall comply with this minimum value.

5.3 Axial compression fatigue properties

The rope shall have demonstrated a residual strength not less than 95 % of MBS, following the axial compression fatigue test method in Annex B. Additional information is given in Annex C.

5.4 Torque properties

Torque-neutral rope or torque-matched rope shall be defined according to ISO 18692-1.

5.5 Cyclic loading performance

The rope shall have demonstrated performance under cycling loading following the requirements of ISO 18692-1.

5.6 Particle ingress protection

Unless otherwise specified, the rope shall be constructed with a protection of the core against the ingress of particles in accordance with ISO 18692-1.

6 Requirements — Rope layout and construction

Rope layout and construction shall be in accordance with ISO 18692-1.

7 Rope testing

7.1 Type testing

7.1.1 General

Type tests shall be performed in accordance with ISO 18692-1 and the specific requirements of this clause.

7.1.2 Sampling

The number of rope samples to be tested is given in Table 2.

Table 2 — Number of samples for testing

Test	Number of samples
Breaking strength, core tenacity, and stiffness[d]	3
Axial compression fatigue [a]	1
Torque properties [b]	1
Linear density	1
Cyclic loading endurance [c]	1

[a] See 7.1.4.

[b] See ISO 18692-1:2018, 7.1.4.

[c] See ISO 18692-1:2018, 7.1.6.

[d] See ISO 18692-1:2018, 7.1.3

7.1.3 Breaking strength ,core tenacity, and stiffness tests

The number of samples from Table 2 shall be tested, and each sample shall be capable of meeting the requirements of 5.1 and of 5.2.

NOTE The measurements of the dynamic stiffness at end of bedding-in — and, when required, those of the quasi-static stiffness and the dynamic stiffness at several mean load level — are performed for design purposes only. There are no acceptance criteria on these parameters.

7.1.4 Axial compression fatigue properties test

One sample shall be tested for axial compression fatigue properties.

There is no need to perform this test when data are available from the previous qualification test of another rope with the same design, material and method of manufacture of rope core, and a size not less than reference number 90.

7.1.5 Torque properties tests

Where applicable, torque properties tests shall be performed according to the procedure specified in ISO 18692-1:2018, 7.1.4 and Annex B.

7.1.6 Linear density test

The linear density shall be calculated from the measured mass and elongation according to the method defined in ISO 18692-1:2018, 7.1.5 and Annex B.

7.1.7 Cyclic loading (endurance) test

The cyclic loading endurance test shall be performed according to the procedure specified in ISO 18692-1.

The residual strength of the rope shall be not less than 80 % of the MBS.

7.1.8 Protective cover thickness

The thickness of the protective cover shall be verified. See ISO 18692-1:2018, 7.1.7

7.1.9 Particle ingress protection

See 5.6 and ISO 18692-1:2018, Annex B.

7.2 Testing of current production

Testing of current production shall be in accordance with ISO 18692-1:2018, 7.2.

8 Report

The report shall be in accordance with ISO 18692-1.

9 Certification

Certification shall be in accordance with ISO 18692-1.

10 Marking, labelling and packaging

The marking, labelling and packaging shall be in accordance with ISO 18692-1.

Annex A
(normative)

Fibre qualification and testing

A.1 General

Fibre qualification and testing shall be in accordance with ISO 18692-1:2018, Annex A, and the following requirements.

A.2 Fibre testing — Hydrolysis properties of aramid fibres

The material shall have a residual strength of at least 90 % of its nominal value (new fibre), after immersion for two weeks in 80 °C water (alternatively 20 weeks at 60 °C).

NOTE The water for this test can be either natural or artificial seawater (e.g. ASTM D 1141).

Testing may be performed on fibres or small cords (braided or twisted).

Accelerated test based on a factor 1 000 in time over 60 °C increase of temperature, e.g. see ISO 9080, to simulate the conditions of a mooring line (20 years in seawater at 4 °C to 20 °C). Test duration may be adjusted if this can be documented by suitable test data.

Annex B
(normative)

Axial compression fatigue properties test

B.1 General

This annex specifies the requirements for axial compression fatigue properties test of aramid ropes for offshore station keeping.

B.2 Testing conditions

B.2.1 Rope samples

The axial compression fatigue tests shall be performed on one sample of the full-size rope. Terminations of samples shall be identical to those used in supplied ropes.

Termination fittings shall be provided with the same type of material and the same profile and dimensions (radius, groove shape) as the thimbles for the supplied rope.

B.2.2 Ambient conditions

The axial compression fatigue test shall be performed under ambient conditions similar as those described for cyclic loading endurance test (see ISO 18692-1:2018, B.2.2).

B.2.3 Testing machine and measurement

The testing machine and the measurement system shall be in accordance with the provisions of ISO 18692-1:2018, B.2.3 and B.2.4. The machine shall be capable of accurately controlling the trough load at 1 % of MBS.

B.3 Testing

B.3.1 Test procedure

The axial compression fatigue test shall be performed according to the following steps.

a) The sample shall be soaked for at least 4 h in fresh water.

b) The test piece shall be installed in the test machine.

c) A load of 2 % of MBS shall be applied.

d) The extensometer shall be installed in a section of the rope undisturbed by the termination.

e) A tension of 50 % of the rope MBS shall be applied at a rate of 10 % MBS/min and held for 30 min.

f) The tension shall be reduced to 20 % of the rope MBS, at a rate of 10 % MBS/min.

g) Cycling tension between 10 % and 30 % of the rope MBS shall be applied 300 times at a frequency between 0,03 Hz and 0,1 Hz.

h) Cycling tension between 1 % and 20 % of the rope MBS shall be applied 2 000 times at a frequency between 0,03 Hz and 0,1 Hz.

i) Unload the sample and pull the rope to failure at a loading rate of approximately 20 % of MBS/min.

B.3.2 Recorded data

The following data shall be recorded:

— type and length of the sample, linear density, and MBS;

— applied cyclic tension load;

— residual strength and as % of MBS.

Annex C
(informative)

Additional information and guidance

C.1 Axial compression fatigue of aramid fibre

The main characteristics of aramid fibre that make it attractive for mooring applications are its high strength, high modulus, and low creep properties even at elevated temperatures[12], [15]. However, compared to PET fibres, aramid fibre is more susceptible to damage from axial compression fatigue. In a rope, this effect will appear when subjected to tension-tension cycles at low loads. This susceptibility contributed to the premature failure of the first aramid fibre mooring rope deployed in 1983[8], [9]. However, in the same period, aramid fibre ropes were successfully used[7] indicating that the actual risk from compression fatigue on a rope level depends on the actual rope design and handling.

Studies and design improvements to address axial compression fatigue issues had resulted in several successful trials or use of aramid fibre mooring or tugging rope[3], [4], [6], [12], [15]. Care should be taken to properly design and test aramid fibre ropes for axial compression fatigue performance in order to ensure endurance of the rope in station keeping use.

C.2 Technical considerations

C.2.1 To avoid failures due to improper design of a rope, it is important to understand and distinguish the factors that play a role in causing compression fatigue. Compression fatigue should be separated in the following effects.

a) Tension-tension fatigue due to cycling at low loads:

Cycling at low loads can give more damage to materials than cycling the same range at a higher load. With aramids, this effect can be more explicit than with, e.g. PET[13], but the principle is similar. The cause of this fatigue effect is partly from the fact that aramids are less abrasion-resistant. During the low load cycling, the movement in a rope is relatively high causing abrasion, but this can be minimized by applying a marine finish and rope jacket material[12], [13], [15]. This has been demonstrated for marine finished aramids with a commonly utilized testing standard for tension fatigue the thousand cycle load limit (TCLL), see Reference [12].

b) Compression of filaments due to length differences, e.g. in the splice area:

When aramid filaments are compressed for more than a 0,6 % strain (up to 1 %), a weak spot will be created which is generally referred to as a kink-band[14]. The effect of such kink-band with regards to the strength of the filament is only significant when the fibre is repetitively compressed more than 0,6 % for at least several hundreds of cycles. When the fibre is subjected to 0,5 % or less compressive strain, studies have showed that no strength loss is found even after several hundred thousands of cycles[8]. Especially when filaments are locked into their position, this effect might appear. This affects the splice area (and ropes with large length differences within the rope also causing low strength efficiency).

C.2.2 The risk from the axial compression fatigue can be minimized by the following methods.

a) Improve rope design to minimize local compression especially in the splice areas;

b) Establish proper rope minimum tension criteria and analysis procedure;

c) Conduct rope axial compression fatigue test to demonstrate adequate resistance to failure.

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